

Geographical Information System (GIS) Analysis of Earthquake Destruction Pattern in Pakistan

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Abstract

This research work found two threatening earthquake sources right inside Pakistan, around Muzaffarabad in Kashmir and around Quetta in Baluchistan. While the third source was in Hindu Kush in North-Eastern corner of Afghanistan near the North-Western border of Pakistan threatening Chitral, Ghizer, Dlamir, Drupper, Swat and Kohistan of Pakistan. The results showed the 100% matching with the real life earthquakes that occurred in Pakistan in terms of the depth and month of seismic activity. For the 5-year period from 2005 to 2009, the maximum seismic activity depth and month were found to match with the month and depth of occurrence of both earthquakes, that of Muzaffarabad on October 08, 2005 and that of Ziarat earthquake on October 29, 2008. Both earthquakes occurred in the month of October and at the depth of 10 km and were crucial in causing the collapse of houses and destruction of property and civil structures.

Introduction

This research on analytical evaluation of earthquake destruction pattern in Pakistan became essential as the earthquake of magnitude 7.6 in Seattle, Western Coast of USA had no casualty, i.e. zero loss of life while the earthquake of same magnitude of 7.6 at Muzaffarabad on October 08, 2005 played havoc in the region and took the toll of more than 80,000 lives. Furthermore, the recorded data on earthquakes from magnitude 2.5 and above since 1973 till today is readily available as the most reliable database of Geological Survey of United States of America (USGS). In this research work, only the part of database has been used only for the period of five years from 2005 to 2009. It was believed that the combined use of Geographical Information

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System Analysis and Global Mapper on the USGS data base will give dependable results as the accuracy and reliability of USGS are high. This research paper has been planned to use the Geographical Information Analysis (GIS) and Global Mapper to plot the threatening sources of earthquakes in Pakistan based on the recorded data of seismic activity by Geological Survey of United States of America for the period of five years from 2005 to 2009. The results on seismic activity would be used to verify the recorded data of USGS database so far accuracy and reliability is concerned, purely based on the seismological fact that the 90% of earthquakes happen along the tectonic plate boundary in the real life experience of earthquakes and the neighboring areas of tectonic faults can be seriously affected.

Research Methodology

The data base of Geological Survey of United States of America was used and with the help of Global Mapper Software package, the data from USGS was plotted on the specific geographical areas in the region to evaluate the frequency of the seismic activity so that the crucial sources of earthquakes can be identified in Pakistan for proper planning and streamlining of the loss mitigation efforts which can be directed effectively to save precious lives and protect property and civil structures of the country in the future earthquakes. The results were scheduled to go under the process of statistical analysis so that the verification check of the results can also be safely carried out.

Results

The USGS database which records the earthquake events of almost all magnitudes from 2.5 to 9 and above for the entire world, was used for the period of 5 years from 2005 to 2009 to plot the earthquake events of magnitude above 4.5 to identify and evaluate the threatening sources of earthquake disasters in Pakistan. The Geographical Information System (GIS)

Analysis was used to specify the geographical locations in Pakistan using the software package of Global Mapper for this purpose. The results obtained

through the above mentioned methodology have shown tremendous matching with the real life experience of the earthquake events occurring throughout the world to the extent that the plotting resulted on the global map to show the clear demarcation of the global tectonic plates. It is geo-seismological fact that the boundaries of tectonic plates provide the weakest joints for the release of accumulated slip energy resulting into the 90% frequency of the earthquakes to occur along these tectonic plate boundaries.

EQ events around the world from 2005 to 2009 (>4.5 mag.)

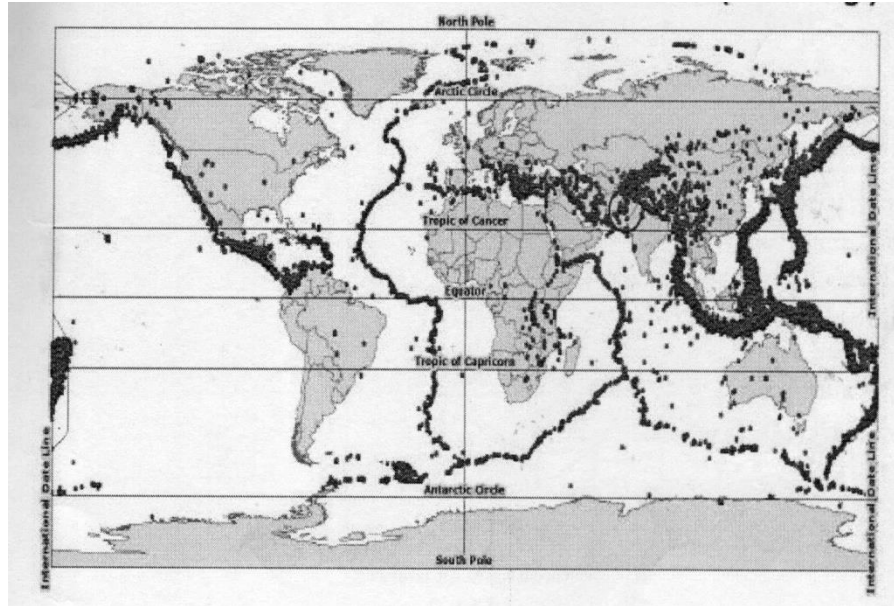


Fig: 1

Evolved by the Author

Result One: Pakistan is shown in a small circle with seismic activity along the boundary of Indian tectonic plate with Eurasian plate through Pakistan Karachi-Khuzdar-Quetta-Derar Ismail Khan-Dera ghazi Khan-Peshawar-Islamabad-Muzaffarabad crossing Indian border to Himalayan footsteps. The first result has confirmed the fact that toe USGS database of the recorded earthquake (EQ) events by the monitoring stations of USGS, are accurate and

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reliably dependable. Furthermore, the plot has clearly demarcated the tectonic plates by simply plotting the frequency of EQ events telling us the geological fact that 90% of earthquake events occur at the borders of the tectonic plates which are the joints between huge tectonic plates that naturally provide the weakest areas from where the accumulated slip energy is released causing more frequent earthquakes along the main fault lines of the boundaries of the tectonic plates.

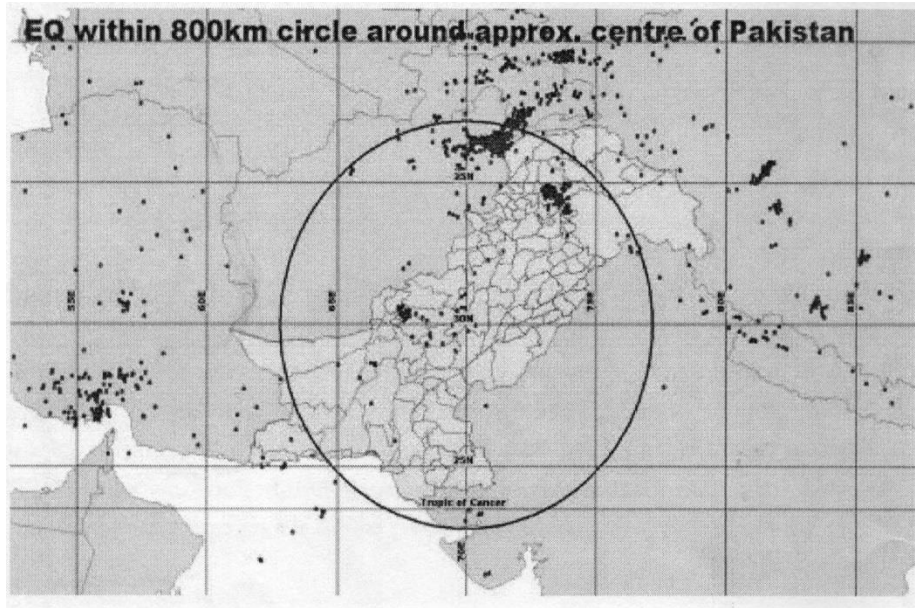


Fig: 2
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Result Two: Three areas (Hindu Kush, Muzaffarabad and Quetta) seismically active within 800 km from the center of Pakistan.

The second result shows clearly that the seismic activity threatening Pakistan are concentrated at three locations of Hindu Kush, Muzaffarabad and Quetta. Although the Hindu Kush is in Afghanistan but it is very close to its border in North-West of Pakistan and its seismic activity poses serious danger of

earthquake destruction to neighboring areas of Chitral, Ghizer, Dlamir, Drupper, Swat and Kohistan of Pakistan.

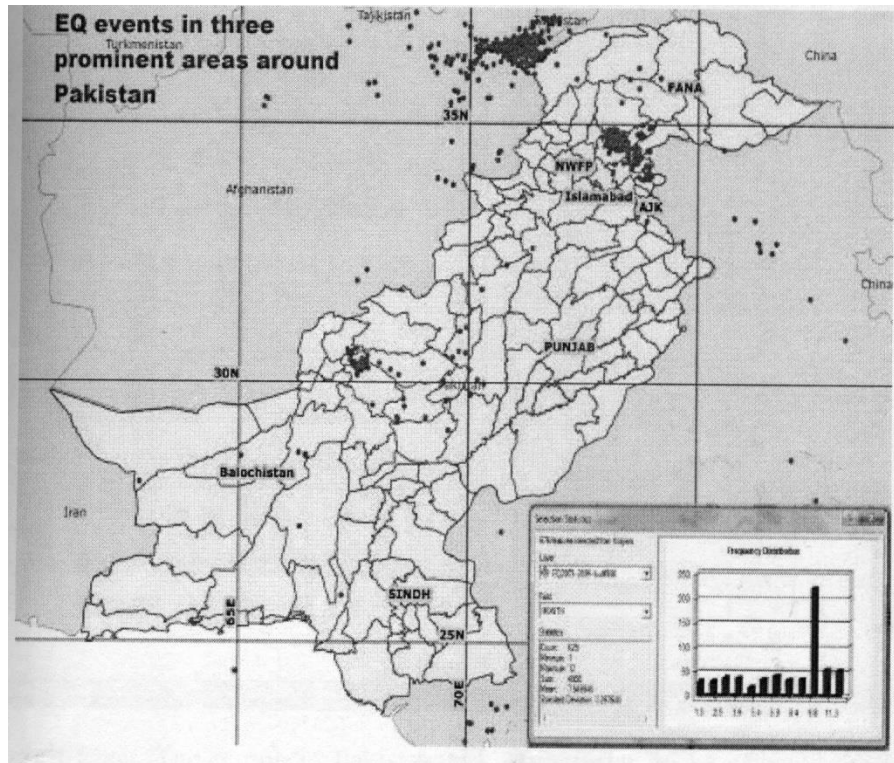


Fig: 3

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Result Three: Mapping of earthquake events for three areas (Hindu Kush, Muzaffarabad and Quetta) to show the month of peak seismic activity every year in the period of five years from 2005 to 2009. The third result has also evaluated the month of maximum seismic activity which is clearly the month of October and this result obtained from the database only for the period of 5 years from 2005 to 2009 helps to understand why the major earthquakes like Muzaffarabad earthquake of 7.6 magnitude on October 08, 2005 and Ziarat earthquake of magnitude 6.4 on October 29, 2008 have occurred in the month

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of October coinciding with the maximum seismic activity peaking in the month of October every year in the period of 5 years from 2005 to 2009.

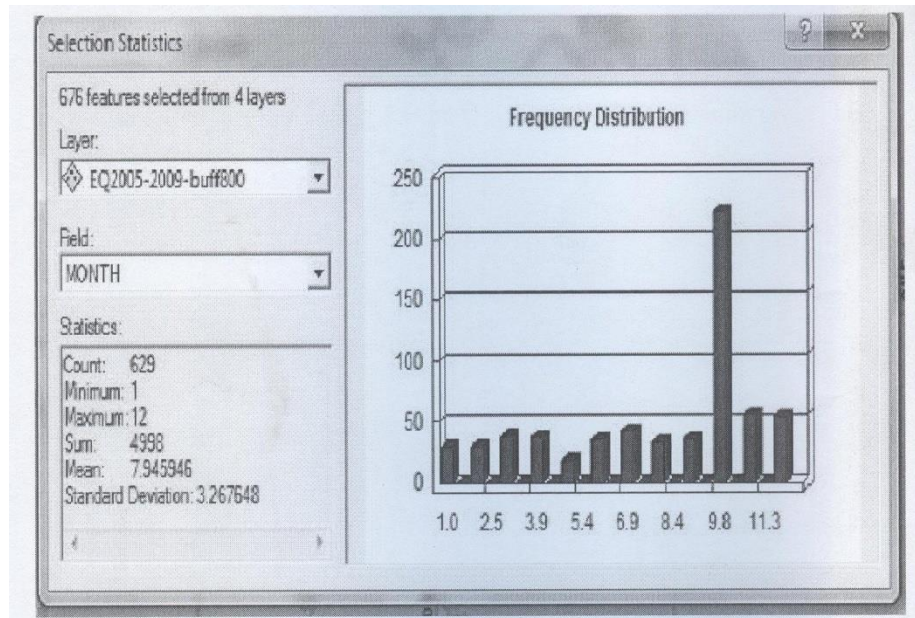


Fig: 4
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Result Four: Statistical analysis of seismic activity based on USGS data base for the period of 5 years (2005 to 2009) to find the month of maximum seismic activity. The fourth result clearly shows separately the peak concentration of seismic activity in the month of October. This is obtained as the result of statistical analysis of the total 629 events recorded by USGS database in the period of 5 years from 2005 to 2009. The reliability of USGS data base is once again verified to be accurate and reliably dependable due to the fact that the month of October has remained the month of maximum seismic activity every year of the seismic activity recorded by the monitoring stations of USGS throughout the world for the period of five years from 2005

to 2009 when two major earthquakes in Pakistan occurred in the month of October coinciding with the recorded maximum activity by USGS.

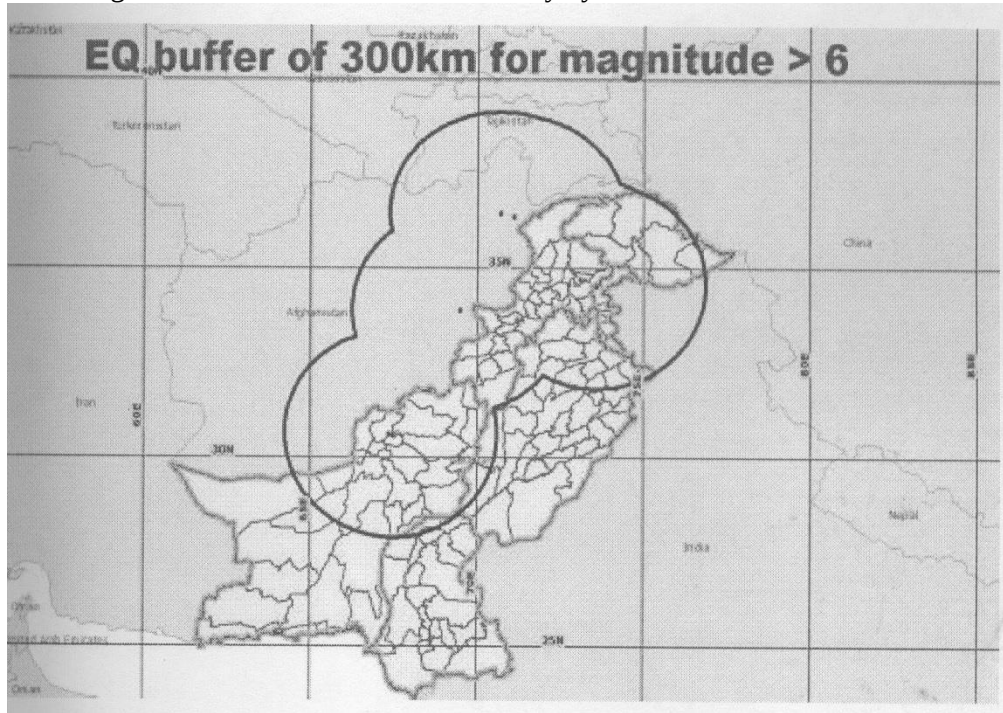


Fig: 5

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Result Five: The region in Pakistan and Afghanistan to be affected by the seismic activities of three areas of Hindu Kush, Muzaffarabad and Quetta are clearly marked out of the map of the region.

The result five shows clear cut parts of Pakistan, Afghanistan, India and Tajikistan forming the vulnerable zone receiving the effects of tremors originating from three sources, i.e. Hindu Kush, Muzaffarabad and Quetta. The planners of the disaster management in each country can devise their appropriate measures for preparedness to mitigate the loss of precious lives and valuable infrastructure, property and important civil structures of public convenience.

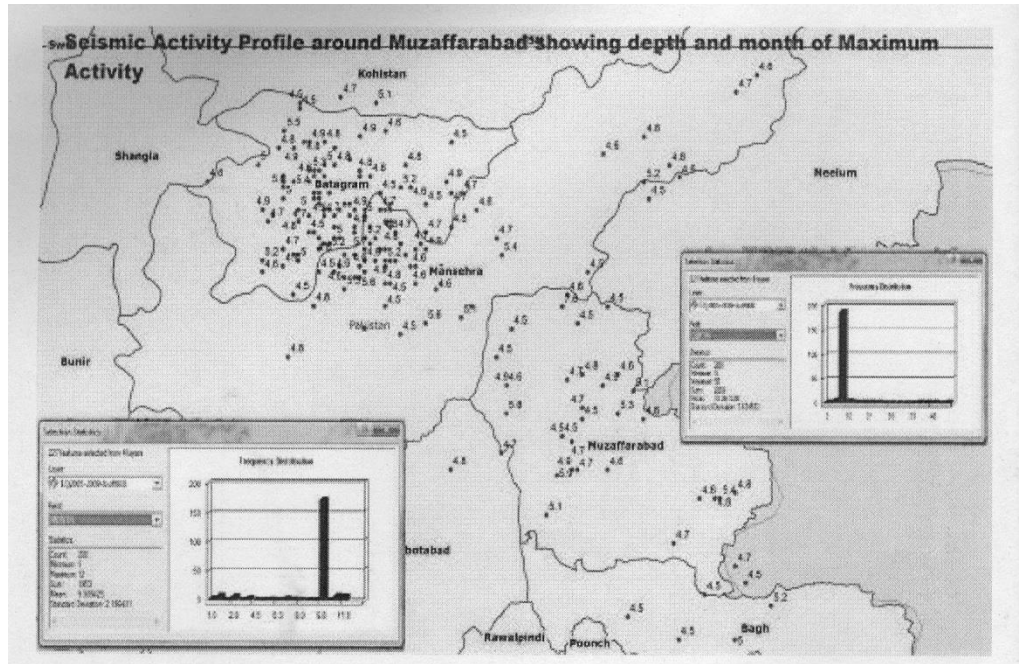
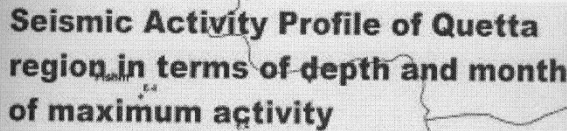


Fig: 6
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Result Six: Seismic Activity Profile around Muzaffarabad showing depth and month of maximum activity. The result six shows the statistical results with respect to depth and month of maximum activity when the seismic activity profile of Muzaffarabad area obtained from USGS for the period of five years from 2005 to 2009 was statistically analyzed. The range of depth was from the minimum of 3 km to the maximum of 55 km, but in terms of the frequency distribution of occurrence of the events, all depths from 3 km to 55 km were negligible except the depth of about 10 km came out prominently in the total of 208 events out of 227 events. Similarly, as shown in the inset on the left side of the map, the prominence of frequency distribution of events in the month of October has been statistically analyzed and exhibited.



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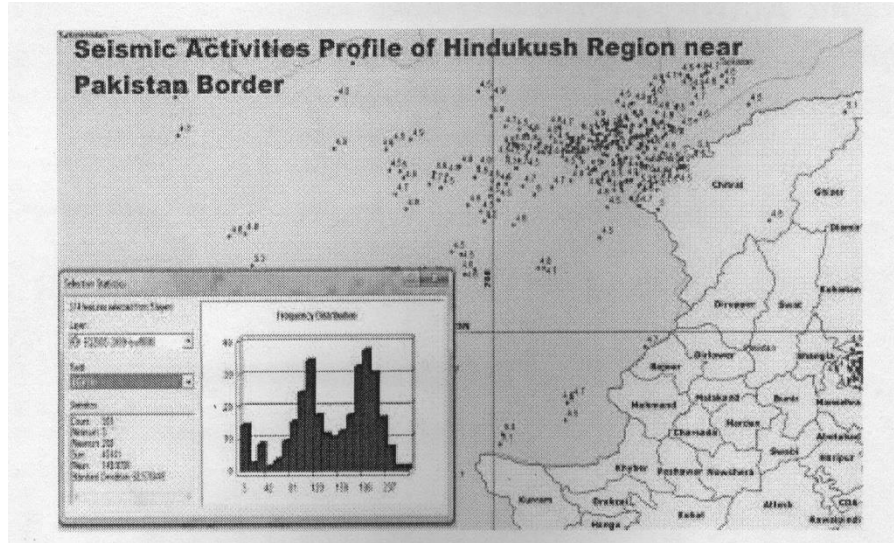


Fig: 8

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Result Eight: Vulnerability of Chitral, Ghizer, Dlamir, Drupper, Swat and Kohistan to seismic activity in Hindu Kush of Afghanistan being close to the border. Hindu Kush shows seismic activity peaks at two depths, 115 km and 200 km. The result eight shows the profile for seismic activity for Hindu Kush region being close to the north-western border of Pakistan and points out to the statistical analysis result obtained with respect to the depth of seismic activity in the area shown as inset in the map. Out of the total count of 301 events, only 3 events contribute to the minimum and 268 events contribute to two peaks shown at 112 km and 210 km depths however, there is considerable contributions from the depths around the maximum of 112 km with the swing of variation of 15 km on either side of the maximum forming the cluster of varying depth activity. Similar cluster of varying depth activity is recognized around the 210 km depth.

Conclusion

Although subduction boundary fault of Indian tectonic plate with Eurasian plate passing through Pakistan starts near Karachi and goes straight to north via Khuzdar to Quetta from where it curves around in a loop passing through

Dera Ismail Khan and Dera Ghazi Khan and touching the border of Afghanistan at Peshawar goes to Muzaffarabad in Kashmir via Islamabad. But, the threatening sources of earthquakes for Pakistan were located at three different areas. Two sources were inside Pakistan, one around Muzaffarabad in Kashmir and the other around Quetta in Baluchistan, while third was located inside Afghanistan but very close to North-western border of Pakistan which can affect the neighboring Chitral, Ghizer, Dlamir, Drupper, Swat and Kohistan of northern Pakistan. After the jolts of October 08, 2005 earthquake of Muzaffarabad and the subsequent long trail of aftershocks have caused the serious geological changes in the affected areas with the result of opening the corridor of seismic activity flow of tremors and jolts even originating from Hindu Kush to easily travel from Islamabad to reach even Multan via Lahore when Lahore was considered safe before the advent of Muzaffarabad earthquake in 2005. Results 1, 2 and 3 have revealed the accuracy of USGS database through full matching of the results with geo-tectonic boundary lines and the seismic activity frequency mapping in Pakistan as well as location of three sources of earthquakes for Pakistan by considering the circle of 800 km from the center on the map of Pakistan. Result 4 has shown the statistical analysis of the result of frequency of seismic activity in terms of the maximum activity month of the year for all the data pertaining to the period of five years from 2005 to 2009. The remaining results from 5 to 8 have concluded that the real life earthquakes in Pakistan in 2005 and 2008 and the involved areas of Muzaffarabad and Quetta are matching with the results obtained from the USGS database so far the month and depth of maximum activity are concerned.

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